Station	Normal rainfall in use previous to 1894	Normal rainfall in use since 1894	1892		1893		1894		1895		1896	
			Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal
Suegor	41·03	45·67	47·21	+ 6·18	61·50	+ 20·47	69·96	+ 24·29	42·16	− 3·51	37·13	− 8·54
Allahabad	33·43	37·00	32·92	− 0·51	45·94	+ 12·51	69·60	+ 32·60	25·94	− 11·06	19·93	− 17·07
Motihari	42·52	47·60	65·16	+ 22·64	79·31	+ 36·79	43·12	+ 0·60	57·29	+ 14·77	28·84	− 18·76

which the year is divided in India, whereas from March 1895 to March 1896 it was more or less in defect in each season, as is shown by the data of the following table.

The variations in this table are calculated from the data of over 2000 stations for which normal monthly means have been calculated, and no allowance is made for the area represented by each station. The total annual variation hence varies considerably according to the two methods of calculation, but it will be seen that they agree in the general character of the cyclical variation :—

Year	Rainfall variation of whole of India (excluding Burma)				
	January and February	March to May	June to Sept.	November and December	Of whole year
	Inches	Inches	Inches	Inch	
1892	−0·37	+0·42	+4·39	−0·96	+3·48
1893	+1·42	+3·62	+3·39	+0·49	+8·82
1894	+0·53	−0·10	+7·56	+0·31	+8·30
1895	+0·04	−0·08	−3·27	−0·72	−4·03
1896	−0·45	−1·09	−3·80	+0·33	−5·01

The main features of the rainfall during this period were hence not special to the south-west monsoon, but general and affecting the meteorology of the whole year. This fact indicates that the causes of the periodic variations are not only general, but due to more or less permanent and persistent meteorological conditions or actions affecting the meteorology of the whole period over a considerable portion of the earth's surface.

It has apparently been established in the discussion that the variations of the rainfall in India during the past six years are parallel with and in part, at least, due to variations in the gradients, and the strength of the winds in the south-east trade regions of the Indian Ocean. The discussion has indicated that there are variations from year to year in the strength of the atmospheric circulation obtaining over the large area of Southern Asia and the Indian Ocean, and that these variations are an important and large factor in determining the periodic variations in the rainfall of the whole area dependent on that circulation, and more especially in India. It has also been indicated that these variations which accompany, and are probably the result in part of abnormal temperature (and hence pressure), conditions in the Indian Ocean and Indian monsoon area may be in part due to conditions in the Antarctic Ocean, which also determine the comparative prevalence or absence of icebergs in the northern portions of the Antarctic Ocean.

The economic effects of these very large variations of rainfall during the past five years has been very great, almost disastrous, in India. The variations are so large in amount, and affect so vast an area, as to suggest that meteorological science should have no difficulty in assigning the causes or chain of actions leading up to these effects. Facts have been given in the present paper which suggest an explanation, but it is doubtful whether it can be regarded as satisfactory.

There appear to be only two explanations possible of this periodicity. The first is that it represents large cumulative effects of opposite phases in different parts of the earth. So far as the whole Indian monsoon area is concerned, the variations in different parts have not been compensatory; and the rainfall in 1896 has almost certainly been below the normal, on the mean of the whole area. It would be an interesting study for a Central International Weather Bureau to investigate. So far as can be judged from a brief examination of the weather reports of other countries, there appear to have been no large and marked periodic variation in other parts of the world corresponding to the variation in India—of either the same or opposite phase. It is hence, on the whole, probable that the periodic rainfall variation of the past five years in India has not been compensated by a similar variation of opposite phases elsewhere. If it were the case, it would be purely a question of meteorological investigation.

The second explanation is that this periodic variation of rainfall in the Indian Ocean during the past five years may be one phase of general actions in the earth's atmosphere, due to abnormal variations in the radiation and absorption of solar energy, and hence to some abnormal phase of the sunspot periodicity. Perhaps the observations recorded at Solar Physics Observatories during the past five years may throw light on the question; and if such be the result, it would furnish a powerful argument for India assisting in the work of Solar Observatories to a much larger extent than she has hitherto done.

The question which now affects India most seriously is, whether the rainfall of the present monsoon is likely to be seriously in defect.

An examination of the figures certainly indicates a probability that the mean rainfall of the year will be below the normal. If the causes of the variations were known with certainty, it would probably decide the question. J. E.

THE INSTITUTION OF CIVIL ENGINEERS.

ON Tuesday, Wednesday, and Thursday of last week, May 25, 26, and 27, the Institution of Civil Engineers held a conference. This is a thing unprecedented in the annals of the Institution, it having confined itself hitherto to weekly meetings during the London season. Not only were there daily sittings, many of them proceeding simultaneously, for the reading and discussion of several papers, but there were also excursions to works and "other objects of interest." There was, as well, a conversazione; but this is no novelty for the Institution. A very large number of members attended the meetings, the Westminster Town Hall and the Westminster Guildhall having been retained for the purpose. The general plan of the conference was for one or more members to read a short note by way of initiating a discussion. As there were nearly fifty items in the programme, the congress being divided up into seven sections, it will be evident that in the small space at our disposal we cannot even refer to all the subjects brought forward.

Proceedings commenced at half-past ten on Tuesday, May 25, by the President reading a short address in the Westminster Town Hall, in which the scope of the conference was sketched out. The members then dispersed to the different sections. Section I. was devoted to railways, and the proceedings commenced by Mr. Harold Copperthwaite reading a note on rails and permanent way. He was followed by Mr. F. W. Webb, of Crewe, who read a note on the same subject. The discussion was of an entirely practical and professional nature. Mr. Webb introduced a model of a joint chair; that is to say, a device which combined in itself a rail chair and fishplate. It will be a great boon to railway travellers if this apparatus can be introduced, supposing it will fulfil all the promises made on its behalf by its originator, for there is no doubt that a very great part of the jar and rattle of railway travelling is due to the giving of rails at the joints. This fact was illustrated by means of lead fishplates, which Mr. Webb had used for the purpose of showing what was the amount of deflection at rail connections; it was considerable. The joint chair referred to is of massive construction, and care will have to be taken that too much progress is not made in the direction of rigidity, otherwise there will be repeated the old trouble experienced with stone blocks for sleepers; some flexibility is needful for a good road. In

Section II. there were also two subjects introduced, the first relating to concrete in marine works, and the second in relation to approaches of docks. Sections III. and VII. sat conjointly, the former of these two dealing with machinery, and the second with applications of electricity. Messrs. Preece, Ellington and Dr. Hopkinson contributed the notes which opened the discussion; the combined subject for the day being the transmission of power by electricity, by water, and by other agents. Mr. Ellington naturally claimed that water was superior to electricity, a statement which was equally naturally disputed by the electricians present. It is needless to say nothing definite was settled on this many-sided question. Perhaps the most interesting contribution to the discussion was that supplied by Prof. Forbes, who had come to the conclusion that the distance over which power might be profitably transmitted by electricity was not far short of 1000 miles. He had been consulted as to the transmission of power from the Victoria Falls on the Zambesi to the gold mines in Matabeleland and the Transvaal. At first he considered the suggestion altogether impracticable; but on putting together figures with a view to prove its absurdity, some ideas had occurred to him which led him to believe that the scheme was not so chimerical after all. The electrical world will look forward with interest to the development of Prof. Forbes' plans.

The proceedings in Section IV., which deal with mining and metallurgy, were of a very practical nature. The most interesting of the contributions was that by Mr. Bennett H. Brough, in which he gave some interesting particulars of deep mines in the United Kingdom. At Pendleton Colliery, near Manchester, the workings were 3474 feet below the surface, that being the deepest working in Great Britain. The deepest metal mine in the United Kingdom is the Dolcoath Tin Mine in Cornwall, which is 2582 feet deep. These figures are, of course, exceeded in mines abroad; a shaft in the copper mines of the Lake Superior district, the deepest in the world, going down to 4900 feet.

Section V. was devoted to shipbuilding. The proceedings were opened by a very instructive note by Mr. Archibald Denny, of Dumbarton, in which he dealt with the practical application of model experiments in merchant ship design. As is well known, Mr. Denny's firm have the only experimental tank of a private nature in the world, it being modelled after the design of the late Mr. Froude. Mr. Denny gave a description of the method of procedure in carrying out these model experiments. A very good discussion followed the reading of this paper, in which Mr. R. E. Froude, Sir Edward Reed, Mr. Thornycroft, Prof. Biles, Sir William White, and others took part. Section VI. was devoted to waterworks, sewerage, and gas works. On the first day of the meeting the proceedings were devoted to a consideration of the law of allocation of underground water.

On the second day of the conference, Wednesday, May 26, in Section I. (the railway section), the discussions turned chiefly on the economics of light railways. In Section III. the most interesting paper was that contributed by Mr. Bryan Donkin, on "Important Questions in the Economic Working of Steam Engines and Boilers." The author pointed out that for greater efficiency it was desirable to adopt high pressures up to 250 pounds, efficient steam-jacketing, reduction of clearance volumes in surfaces of cylinders, and a high number of revolutions. He pointed out that moderately superheated steam had long been employed on the continent, but was coming into favour here very slowly. Superheating reduces cylinder condensation, but, of course, is attended by practical difficulties, and requires more highly-skilled attendance. Mr. Donkin also impressed on the meeting the advantage of using entropy diagrams. He stated that multi-cylinder engines, with twenty or thirty expansions, are very economical, but are only admissible where the barrels and covers are thoroughly steam-jacketed, or superheated steam is used. He also advised greater compression than is generally used. He advocated the statement of economy in terms of thermal units per I.H.P. hour, and also in thermal units per break H.P. hour, whether for saturated or superheated steam. In dealing with steam boilers he pointed out the need of analyses of gases to determine the percentage of CO_2, CO, and O. He rightly stated that no boiler experiments are complete without such gas analyses. Reference was also made to the use of coal finely ground, which, it is said, was being used on the continent. The information is interesting, remembering the great efforts made many years ago to use powdered coal, and the difficulties which led to the failure of the scheme. It would be interesting to know how these difficulties had been overcome. This note concluded by an advice that all engine and boiler trials should be tabulated in uniform manner. It is satisfactory to know that the subject is likely to be taken up by the Institution. A speech which the President, Mr. Wolfe Barry, made, gives hope that a Committee will be formed to consider and report on this matter, and it is probable some legislation by the Institution will follow. In order, however, to make the Committee complete it should take a wider range than the Institution of Civil Engineers, which, although our premier engineering society, is not the only representative engineering body, more especially in regard to mechanical engineering. Petroleum as a steam-engine fuel was the subject introduced by Mr. Aspinall, the Locomotive Superintendent of the Lancashire and Yorkshire Railway. An interesting discussion followed the reading of this note, but it took rather a practical than a scientific turn. There is no doubt that liquid fuel can be used with great convenience on locomotives, and would speedily supplant coal if it could be obtained in sufficiently large quantities and at a sufficiently low price. At present it is only now and then that it can be economically used; still the Great Eastern Railway have a number of liquid-fuel-burning locomotives in fairly constant use on their system.

The Electrical Section on this day discussed two subjects—namely, "Should generating plant be mounted on springs?" and "Turbines as applied to dynamos." In regard to the former, it may perhaps be said that the gist of the discussion pointed to the fact that when generating plant has been mounted on springs, the results have not been altogether satisfactory; but, nevertheless, by mechanical improvements and alterations in detail, the system might be sufficiently perfected to enable it to be worked advantageously. The problem of using turbines was introduced by the Hon. C. A. Parsons. The subject is an interesting one, and the author was well able to deal with it had he been allowed further time. As it was, the note was decidedly meagre, and the discussion disappointing. Perhaps the paper of most interest on this day was that read in the Shipbuilding Section, by Mr. Parsons, in which he gave some particulars of the wonderful steam-turbine-driven boat which he has recently designed and built. The *Turbinia*, the boat in question, is 100 feet in length, 9 feet wide, and 3 feet draught amidships, having a displacement of 44½ tons; she is, therefore, only half the length, and of very greatly less displacement, than the torpedo-boat destroyers, which have been, hitherto, our fastest vessels. With this little boat, however, Mr. Parsons has made a speed of 32¾ knots; but he anticipates that when some alterations have been made in the machinery, still higher speeds will be reached: we believe up to 34 knots. There is a water-tube boiler and three steam-turbines working on the compound system in series. Each of these turbines has its own propeller shaft, and on each shaft there are three screws threaded in line. The most remarkable part of the machinery is that the propellers make 2200 revolutions per minute, in order that they may be worked direct from the steam-turbines, which must necessarily revolve at a high speed. The I.H.P. is 2100, and the consumption of feed water per I.H.P. per hour, 14½ lbs. The weight of the main engines is 3 tons 13 cwt., and the total weight of machinery, including water in boiler, &c., 22 tons. Thus nearly 100 H.P. is developed per ton of machinery, and nearly 50 H.P. per ton of displacement of boat; it need hardly be said that the figures are unprecedented.

On the last day of the meeting a large number of papers were read; to these we can only make brief reference. In a discussion on ball and roller bearings, Prof. Goodman gave some interesting details of experiments he had made with a bearing having an 8-inch diameter ball-race of the thrust-block type, which ran at 1600 revolutions. He had tried the system of using four points of contact between the ball and race, which had been advocated by a correspondent to a technical journal, and which was said to give the perfect rolling contact, but had found that the system would not work satisfactorily; and it was only when he fell back on the more ordinary double-contact system, that he met with success. A paper by Prof. Biles, in the Shipbuilding Section, on "Improved Materials of Construction," led to an interesting discussion, in the course of which a good deal was said about nickel steel, which is certainly the coming material for shipbuilding if the question of price can be satisfactorily settled; to effect which further deposits of nickel must be discovered and worked economically. In the Harbour and Docks Section, the Hon. R. C. Parsons described an automatic dredging machine he had devised. There was a good discussion on the decimal system, initiated by a note by Captain Sankey; and to the same section, Mr. Spagnoletti contributed a note on the equilibrium system of feeding electric railways. There were two good papers in the Railway Section: one on "Standardising of working loads and working stresses for railway bridges," and the other on "The use of small scale experiments in some engineering problems." These were contributed by Mr. Moncrieff and Mr. Mallock respectively.

THE POPULATION OF RUSSIA.

THE results of the first one-day census, which was made throughout the width and breadth of the Russian Empire on February 9 last, were expected with great interest. The last census was made in 1851, and a partial one in 1858; and yet it was not a census proper, for the local police authorities on the spot merely made lists of the permanent residents and taxpayers in each locality. After much preparatory work, it was decided to make, this year, a "one-day census"; that is, in the lists which had to be made for each house in each locality, all those persons who spent the night in a given house and in a given locality on February 9 (or about that date in the villages), had to be mentioned, whether they were permanent residents or not. It was quite a novel experiment, which was looked at with little confidence; but the Vice-President of the Russian Geographical Society, who had had already a great deal of experience with such censuses as they were made, since 1870, in separate big towns (in these censuses the illiterate population filled their lists, as a rule, admirably well), insisted upon the new method being accepted. The census was organised under his guidance, and seems, so far as can be judged, to have been quite successful. The items, obtained from all the local committees, partly by telegraph—with the exception of some parts of the province of Yakutsk—are now published; and the population of the empire appears from them as follows:—European Russia, 94,188,750; Kingdom of Poland, 9,442,590; Grand Duchy of Finland (Finnish yearly census), 2,527,801; Caucasia, 9,723,553; Siberia and Sakhalin, 5,731,732; the Kirghiz Steppes, 3,415,174; Turkestan, with the Trancaspian Region and the Pamirs, 4,175,101; Russian subjects in Bukhara and Khiva, 6412; total, 129,211,113. The corresponding figures, in 1851, were: European Russia, 52,797,685; Poland, 4,852,055; Finland, 1,636,915; Caucasia, 4,436,152; Siberia, 2,437,184; Steppes, 1,220,654; total, 67,380,645. It may thus be said that although the percentage of births is very high in Russia, it took nearly fifty years for the population to double.

An English writer about Russia made, some time ago, the remark that Russia suffers from *a polism*, that is, from a want of towns. This want has lately very much disappeared. There are now in the empire no less than 19 towns having a population of more than 100,000 (out of which two in Poland, two in Caucasia, and one, Tashkend, in Turkestan); 35 towns with populations from 50,000 to 100,000; and 69 towns with populations of from 25,000 to 50,000. St. Petersburg has already attained the figure of 1,267,023, and Moscow approaches the million (988,610).

It is worth mentioning that no less than 230,000 persons took part in the census; very many of them were volunteers, who were recruited among the students of the Universities and the High Schools.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. H. A. Miers, F.R.S., and Mr. W. Garstang, have been appointed examiners for the Burdett-Coutts Scholarship.

An examination for one or more Natural Science Demyships and Exhibitions will be held at Magdalen College in October. The value of the Demyships is £80 per annum. Candidates must be under nineteen years of age on the day of election, October 18.

The Right Hon. John Morley delivered the Romanes Lecture in the Sheldonian Theatre on Wednesday last. The subject was Machiavelli.

CAMBRIDGE.—Dr. Alex. Hill, Master of Downing College, and University Lecturer in Anatomy, has been elected Vice-Chancellor for the ensuing academical year.

Dr. R. D. Roberts has been appointed a Governor and Member of Council of the University College of Wales, Aberystwyth.

The first Smith's Prize has been awarded to Mr. E. T. Whittaker (bracketed second wrangler 1895), of Trinity College, for his essay on "Multiform Functions." The second prize is divided between Mr. R. C. Maclaurin (twelfth wrangler 1895), of St. John's College, for his essay on "Solutions of the Equation $(\nabla^2 + \kappa^2)\Psi = 0$ in Elliptic Co-ordinates," and Mr. A. E. Western (seventh wrangler 1895), of Trinity College, for his essay on "Quadratic Complex Numbers." The essays of Mr. C. Godfrey, of Trinity, Mr. T. J. I. Bromwich, of St. John's, and Mr. B. Hopkinson, of Trinity, receive honourable mention.

Mr. A. Sedgwick, F.R.S., has been reappointed a Manager of the Balfour Fund for five years. The University table in the Marine Biological Laboratory at Plymouth is to be occupied by Mr. S. D. Scott, of King's; the corresponding tables at Naples are assigned to Mr. F. B. Stead, of King's, and Mr. K. R. Menon, of Christ's.

Prof. Lewis announces a course of lectures and demonstrations in Crystallography during the long vacation. Dr. Kanthack, Deputy Professor of Pathology, will give courses in Bacteriology, in Morbid Anatomy and Histology, and in Pathology.

The Examiners for the Mathematical Tripos announce that ninety men and twenty women "have acquitted themselves so as to deserve honours."

Honorary degrees will, on June 17, be conferred on the Archbishop of Canterbury, Lord Lansdowne, the Chief Justices of England and South Australia, a number of the colonial premiers—Sir George Goldie, Sir Arthur Arnold, Sir John Kirk, F.R.S., and Sir William H. White, F.R.S.

Dr. Percy Gardner, Lincoln Professor of Archæology at Oxford, Dr. Sydney H. Vines, F.R.S., Sherardian Professor of Botany at Oxford, and Dr. H. Marshall Ward, F.R.S., Professor of Botany at Cambridge, all of whom were formerly Fellows of Christ's, have been elected Honorary Fellows of the College.

THE following are among recent appointments:—Dr. J. L. Prevost to be full Professor of Physiology at Geneva; Dr. E. Kaufmann, Privat-docent in Anatomy at Breslau, to be Professor; Dr. K. Zeisig, Assistant Professor of Physics in the Darmstadt Technical High School, to be full Professor; Dr. Max Wolters, Privat-docent in Anatomy at Bonn, to be Professor; Dr. Ludwig Heim to be Assistant Professor of Hygiene and Bacteriology at Erlangen; Dr. M. Siegfried to be Assistant Professor of Physiological Chemistry at Leipzig; Prof. A. J. Moses to be Professor of Mineralogy, and Mr. H. M. Howe Professor of Metallurgy, in Columbia University; Mr. W. G. McMillan, Lecturer in Chemistry and Metallurgy at Mason College, Birmingham, to be Assistant Secretary of the Institution of Electrical Engineers.

THE name of the Michigan Mining School has just been legally changed to the Michigan College of Mines. It is proposed to make the tuition fees approximately the same as those charged by other advanced technical schools in America. When the school was working out its policy, it was thought wisest not to charge tuition, but to collect as wide a constituency as possible in order that there might be all possible chance to make the methods as broad and thorough as could be done. It was also deemed hardly just to the students to demand tuition until the institution was much better equipped for its work than the public assistance given during the first decade of its existence permitted. Now that success has been attained in educating men for practical work, the institution seems fully warranted in charging hereafter for its instruction. The new regulation comes into effect immediately after August 19.

A ROYAL charter, dated May 11, has, says the *Educational Times*, been granted for the establishment in Sheffield of a University College. The council of Firth College, the executive committee of the Sheffield Technical School, and the council of the Sheffield School of Medicine petitioned that those institutions should be consolidated and included in one college, having for its object the provision of such an education as might enable residents in the city and neighbourhood to qualify for degrees at any of the Universities in the United Kingdom. It was represented that the endowments of the institutions were of the aggregate value of 100,000*l*., and that there was reason to anticipate further contributions to a large amount after the incorporation of the College. The charter now granted sets forth, amongst other things, that the institution shall be known as